EPA's Yucca Mountain standard: Nevada's criticism and proposal

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Not on Yucca Mountain—on the EPA proposed rule

Some of Nevada's views, not all.

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New rule almost same as one Court tossed

	Previous rule rejected by Court	Proposed EPA rule
pre-10,000 years	15 mrem dose applied to *mean* Water contamination limit	15 mrem dose applied to *mean* Water contamination limit
post-10,000 years	*Infinite* dose allowed No water contamination limit	*Very high* dose allowed No water contamination limit

The Court rejected an infinitely permissive standard; will it accept a highly permissive standard? Should it?

(350 mrem measured against median of DOE calculations—amounts to about a 1000 mrem standard against mean dose)

How did we get here?

- 1992 Congress had told EPA to write a rule "*based upon and consistent with*" NAS recommendations
- 1995 NAS committee said they
  - "*see no valid justification*" for a 10,000 year limit.
  - *"recommend that compliance assessment be conducted for the time when the greatest risk occurs"*
- EPA ignored the law--it did the opposite from what the NAS recommended
- 2004 Court of Appeal bluntly told EPA it was way off base:
  "Only in a world where 'based upon' means 'in disregard of' and 'consistent with' means 'inconsistent with' could EPA's adoption of a 10,000-year compliance period be considered a permissible construction ... ." (Court of Appeals, July 2004 opinion)
- In the proposed rule EPA adopts a peak dose (more or less). But just having *any* standard at the peak does not do it

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The July 2004 Court opinion quotes NAS REPORT at 6-7.

> NAS reiterated this conclusion throughout its report: "[W]e recommend [t]hat compliance with the standard be measured at the time of peak risk, whenever it occurs," *id.* at 2 (footnote omitted); "we have recommended that the standard for individual risk should apply at times when the peak potential risks might occur," *id.* at 55-56; "we see no technical basis for limiting the period of concern to a period that is short compared to the time of peak risk or the anticipated travel time," *id.* at 56; "[t]he period over which this level of protection should be assessed should extend over the period of duration of hazard potential of the repository, that is, until the time at which the highest critical group risk is calculated to occur, within the limits imposed by the longterm stability of the geologic environment at Yucca Mountain, which is on the order of [one million] years," *id.* at 67.
>
> Not only did NAS recommend that EPA set its compliance period based on peak risk, but it expressly rejected 10,000 years as a proper benchmark: "The current EPA standard [in part 191] contains a time limit of 10,000 years for the purpose of assessing compliance. We find that there is no scientific basis for limiting the time period of an individual risk standard in this way." *Id.* at 6; *see also id.* at 55 ("[W]e believe that there is no scientific basis for limiting the time period of the individual-risk standard to 10,000 years or any other value."). A 10,000-year limitation, NAS explained, "might be inconsistent with protection of public health." *Id.* at 55. . . .
>
> EPA's own explanation of its treatment of the NAS Report also reveals that the agency consciously and outrightly rejected the Academy's findings and recommendations.

Why is the peak dose so important?

- Defense-in-depth– the *sine qua non* of nuclear safety—requires redundancy between package and site
  - *The overall performance of the geological disposal system shall not be unduly dependent on a single barrier or function.*
    IAEA Safety Requirements for Radioactive Waste, April 2005*
- The dose peak comes after the packages fail—it measures the site's capacity to contain radioactivity.
  - *The Court of Appeals judges understood this very well in insisting on a peak dose standard.*
- EPA has a waste repository dose standard–15 mrem/year
- The obvious response to the Court is to apply that standard to the peak, whenever it comes
  - But EPA recoiled from this proposal because DOE's calculations show a high peak after 10,000 years—one much higher than 15 mrem
  - The meaning of a high peak is, of course, simple—*it means the site is no good.*
- Instead, EPA proposed a two-tiered standard comfortably above DOE's calculated peak doses, with the higher tier at "350 mrem/year"

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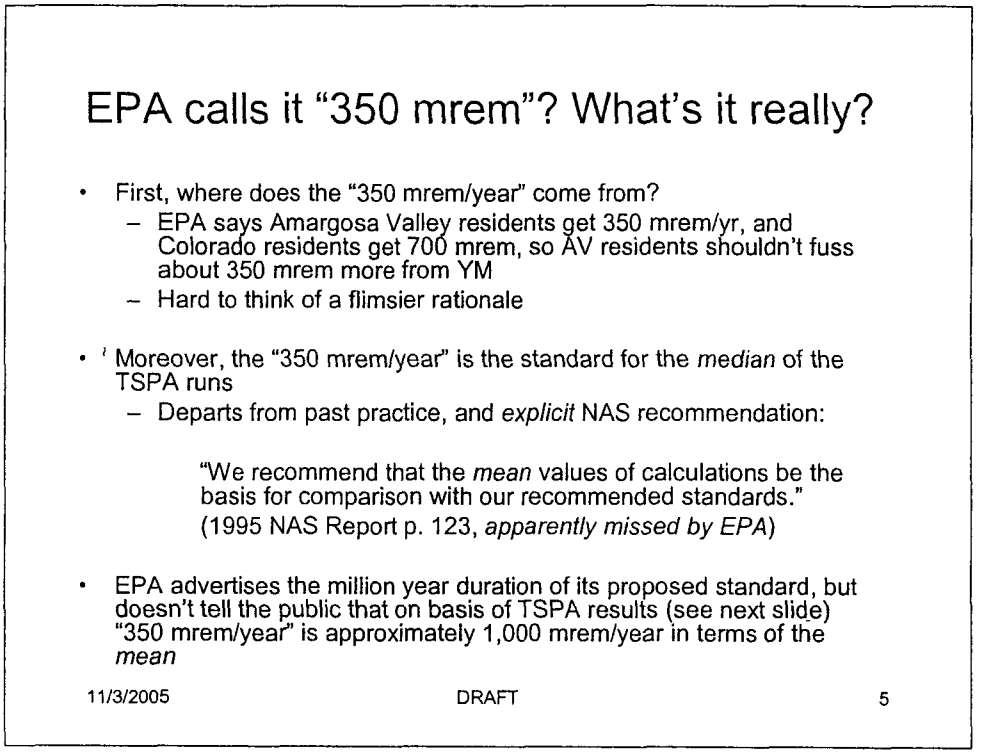
(EPA background reference 0051, "Geological Disposal of Radioactive Waste," IAEA Draft Safety Requirements (DS154), April 2005)

At a good site there is no significant peak and time of compliance is not an issue

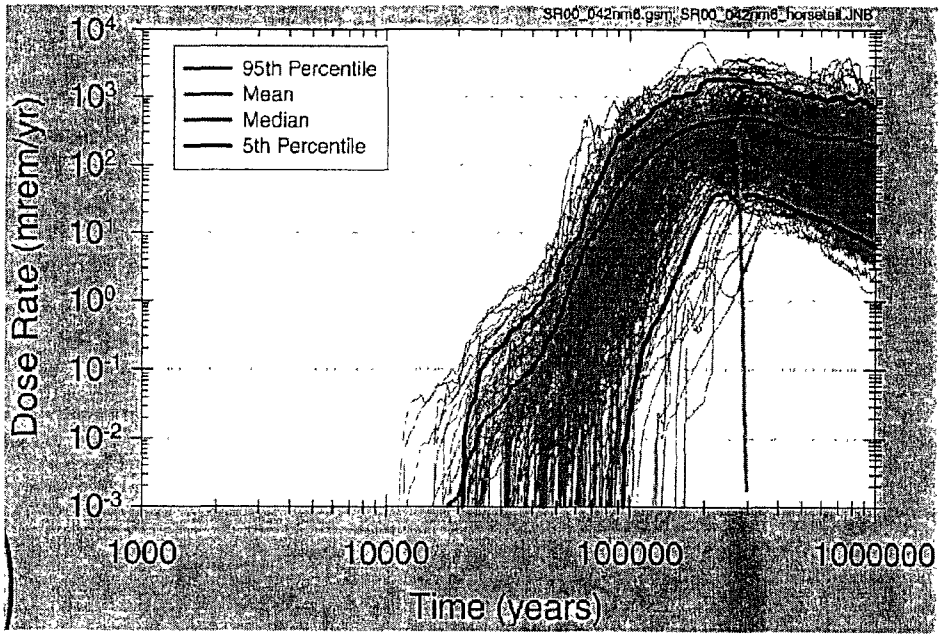
For example, WIPP has a 15 mrem standard for 10,000 years.

This does not pose a problem because: "Under expected undisturbed conditions no releases from the repository are anticipated" (EPA FR 6/13/2001)



Among other problems with this comparison with Colorado, EPA's figures include radon doses which shouldn't belong here

On the use of the median, consider, for example, a simplified but instructive example: suppose we need to characterize a batch of 300 TSPA runs out of which 151 show essentially no public impact and 149 show catastrophic impact. Using the median would characterize the 300 runs by the 151st which shows no impact and the project would pass muster. The 149 catastrophic results would play no role.



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The median ignores high dose cases

- EPA's *stated* purpose in using the median is to toss out high consequence TSPA simulation runs--is this valid?
- This is *not* like throwing out strange experimental results--say, because they are so odd something must have gone awry
- In this case, all TSPA runs reflect parameters taken randomly from distributions *assigned by DOE*--all runs should be equally valid*
- And it isn't as if DOE needs to be reined in because it is inclined to use overly conservative models

EPA's line of argument is essentially that "reasonable expectation" plus uncertainty in model accuracy and model parameters is justification for throwing out high cases, and they slip the median into the rule to do the job.

EPA doesn't think it is worth trying to get better models. It's happy with the answer it has. For example:

> Expending additional effort for site characterization and flow modeling to reduce the uncertainty in transport times would have no significant effect on the dose projections and compliance decision making, since reducing the uncertainty would not move the peak dose time to within the 10,000-year period.
>
> Cohen & Assoc. Report A-15

OK, why worry if peak is in remote future?

- Because it isn't necessarily in the remote future—it could come much earlier (see next slide).
- The supposed long times for the Yucca Mountain peak—hundreds of thousands of years—are a construct of DOE's TSPA computer simulation model
- In particular, they are the result of highly optimistic assumptions about the *key uncertainty—waste package corrosion*
- DOE's "time" is just the time parameter in the *TSPA simulation model*. We don't know when doses will really occur.
- At this point, DOE's simulation result should have no claim on our confidence—it is, so to speak, the scientific brief of an interested litigant, a brief not yet seriously tested
- It is improper for EPA (or NRC) to assume the peak is far off and then write permissive safety rules based on that assumption

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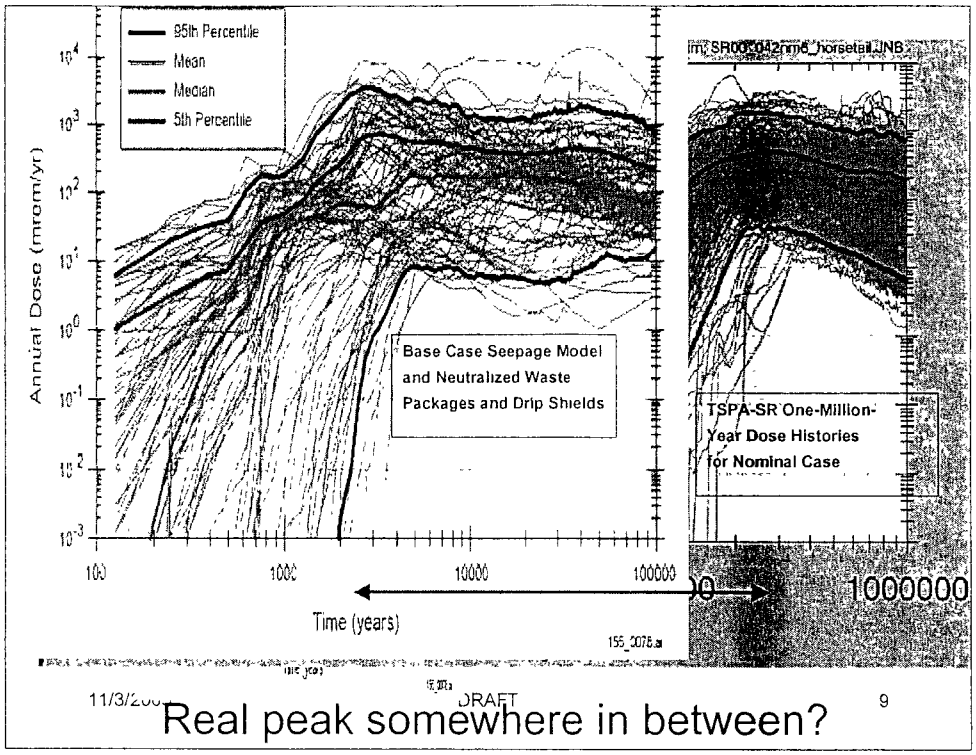
On the uncertainty surrounding waste package corrosion, this is what EPA's principal contractor says:

> Unlike most concepts adopted by other nations, the proposed Yucca Mountain repository exposes the metallic waste packages (WPs) and drip shields (DSs) to sustained oxidizing conditions. Under those circumstances, *corrosion of the WP and DS alloys exposed to moisture is limited neither by natural immunity of the metal nor by starvation of the oxidant agent.* Instead, corrosion resistance results from the presence of an extremely thin oxide film (the "passive film") on the alloy surface, which acts as a surface seal greatly lowering the rate of metal oxidation. . . .
>
> Under certain conditions, passive films are susceptible to localized breakdown that exposes the underlying metal, without regeneration of the film. *Localized Corrosion then ensues that, if present, could relatively quickly penetrate through the WP wall or DS.* . . .
>
> Engineering experience with passive metals is *extremely short* (i.e., approximately 100–150 years) compared with the timeframe of repository performance projections. *Extrapolation of present knowledge to the longer timeframe is thus highly uncertain* . . .
>
> S. Cohen & Associates, *Assumptions, Conservatisms, and Uncertainties in Yucca Mountain Performance Assessments*, August 8, 2005 (emphasis added)



Somewhere in between?

TSPA-SR One-Million-Year Dose Histories for Nominal Case

(as Figure 12.1 of S Cohen & Associates, 2005, but reproduced from SSPA, Volume 2, Figure 3.1.2-1)

Figure 3.2.2-12 from Volume 2 of the SSPA, illustrating a Case with the Base Case Seepage Model and Neutralized Waste Packages and Drip Shields

But if peak is early, doesn't 15 mr apply?

- Not necessarily. We have to distinguish between simulation and reality.
- EPA is setting a design standard that applies to a computer *simulation* that projects performance far beyond our experience base
- After closure, errors will be *irretrievable*
- The 15 mrem standard applies only if NRC concludes that the peak comes before 10,000 years; otherwise the permissive post-10,000 year standard applies to the design
- Now, what if NRC accepts DOE's optimistic package corrosion estimates, but in real life the packages fail earlier?
- The site won't limit doses to 15 mrem—the radioactive particles won't know about EPA's rule, they will follow Nature's rules
- The practical effect of the 10,000 year cutoff—in old and new rules—is to eliminate defense-in-depth protection *for the pre-10,000 year period, as well.*

EPA hangs its hat on "uncertainty"

- But uncertainty calls for *tighter* standards, not more permissive ones, as EPA argues
  - If we can't be sure when the peak come we should cover the contingency that it will come early and apply a tighter standard, a flat 15 mrem
  - If we are so uncertain that we don't know how the system will behave we should reject the site altogether
- Additionally, a philosophical point--comparing YM with the space program:
  - DOE's long-term YM simulations, and the scientific work underlying it, are directed to one goal—getting an NRC license
  - The consequences of post-closure errors will come too late to affect today's repository designers—unlike, say, a space program failure ("O" rings)
  - Human nature, being what it is, tells us professional self-discipline for "getting it right" will not be the same
  - In short, the long range nature of repository design demands exceptionally high *regulatory* standards
- More generally, a permissive approach to quality and safety for the post-closure period will likely infect the pre-closure operations, as well—in fact, it already has

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Cohen & Assoc. Report, A-11:

> Because of increased uncertainty over long time periods, it could be argued that increased effort should be directed to design, site characterization, and assessment methodology development in an attempt to reduce uncertainty. While such a rationale has some appeal, it must also be recognized that there are inherent limits to the extrapolation of field and laboratory information used to make performance projections into the unprecedented time frames under consideration for geologic disposal. These uncertainties should be understood so that resources are expended in ways that demonstrably improve performance and safety. The reasonable expectation concept is therefore essential in order to preclude unreasonable and unconstrained efforts to reduce uncertainties in components of the disposal system that do not control performance.

YM rule fails comparison with WIPP

- EPA fact sheet states Yucca Mountain safety objective:
  "Ensure that people living near Yucca Mountain are protected to the *same level as those living near the Waste Isolation Pilot Plant* in Carlsbad, New Mexico . . . "
- Despite a superficial similarity—WIPP has a 15 mrem standard for 10,000 years—YM doesn't come close to meeting above objective
  - WIPP has no water flow and EPA says no migration of waste expected;
  - WIPP's 10,000 year standard is, in effect, an infinite standard
- By contrast, Yucca Mountain's waste containment is based on delayed leakage
  - Water flow through mountain
  - DOE calculates substantially increase in public dose after 10,000 years
  - To match WIPP's safety EPA would have to extend 15 mrem to peak dose

Much weaker safety regime than reactors'

	NRC REACTORS	EPA/NRC YUCCA MOUNTAIN
Basic standard	"Reasonable assurance"	EPA still pushing for weaker "*reasonable expectation*"*
Defense in depth	Multi-barrier	Overwhelming reliance on package
Separate standards for individual barriers	Yes	No
Allowed dose	<10 mrem/year to an individual *continually* at highest dose point offsite	EPA Yucca Mountain dose : ~1000 mrem/year on average at 18 km (*after diluting the waste stream and prescribing a limited amount of water use per individual*)
Dealing with errors	Corrected through inspection and enforcement	*Irretrievable* after closing, and probably soon after emplacement

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*On "reasonable expectation", EPA fails to acknowledge the following in the Court July 2004 opinion and still maintains that "reasonable expectation" give it more leeway:

> "5. NRC's "Reasonable Expectation" Standard
>
> . . . . NRC explained in its brief that there is "no consequential difference" between the reasonable assurance and reasonable expectation standards and that the two are, in fact, "[v]irtually [i]ndistinguishable." Respondent's Br. at 47-48. Moreover, during oral argument, counsel for NRC confirmed that the two standards are substantively identical. *See* Oral Argument Tr. at 106-07. Nevada deemed NRC's representation sufficient to satisfy its claim. *See* Petitioners' Reply Br. at 29 (noting NRC's "welcome" concession that reasonable assurance and reasonable expectation are "identical" standards)."

Cohen & Assoc. Report, Appendix A:

> ". . . . As noted above, the Court decision did not affect, and EPA is not proposing to change, the "reasonable expectation" approach in the treatment of uncertainties. A difference between the 2001 rule and the current effort is the extension of the compliance period for the individual protection standard to the time of peak dose. The principle of 'reasonable expectation' suffices to prevent unreasonable demands for additional data collection and exhaustive analysis."

EPA clearly doesn't think the two standards are virtually indistinguishable.

Rule at odd with IAEA safety principles

- IAEA "Safety fundamentals, Principle 4":

  Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will *not be greater than relevant levels of impact that are acceptable today.*

- Requirements for multiple safety functions [defense-in-depth]

  . . . safety shall be provided by means of multiple barriers whose performance is achieved by diverse physical and chemical processes. *The overall performance of the geological disposal system shall not be unduly dependent on a single barrier or function.*

(EPA background reference 0051, "Geological Disposal of Radioactive Waste," IAEA Draft Safety Requirements (DS154), April 2005)

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0044"Safety Indicators in Different Time Frames for the Safety Assessment of Underground Radioactive Waste Repositories," International Atomic Energy Agency TECDOC-767, 1994 (32 pp, 2,294 Kb)

0045"Regulatory Decision Making in the Presence of Uncertainty in the Context of Disposal of Long Lived Radioactive Wastes," International Atomic Energy Agency TECDOC-975, 1997 (34 pp, 2,577 Kb)

0046"The Handling of Timescales in Assessing Post-Closure Safety: Lessons Learnt from the April 2002 Workshop in Paris, France," Nuclear Energy Agency (Organisation for Economic Co-Operation and Development (OECD)), 2004 (copyrighted)

0051"Geological Disposal of Radioactive Waste," International Atomic Energy Agency Draft Safety Requirements (DS154), April 2005 (51 pp, 254 Kb)

0061"Principles and Standards for Disposal of Long-Lived Radioactive Wastes," Neil Chapman and Charles McCombie, Elsevier Press, 2003 (12 pp, 426Kb) (EPA web site)

0062"An International Peer Review of the Yucca Mountain Project TSPA-SR," Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, OECD, 2002 (3 pp, 77 Kb)

0076Technical Bases for Yucca Mountain Standards (the NAS Report), National Research Council, National Academy Press, 1995 (copyrighted)

0077"Assessment of Variations in Radiation Exposure in the United States," EPA Technical Support Document, July 2005 (33 pp, 722 Kb) (EPA web site)

0085"Assumptions, Conservatisms, and Uncertainties in Yucca Mountain Performance Assessments," EPA Technical Support Document, July 2005 (356 pp, 8,515 Kb) (EPA web site)

0086DOE Final Environmental Impact Statement, DOE/EIS-0250, February 2002 (1pp, 10 Kb) (EPA web site)

EPA should extend 15 mrem standard

1. To provide defense-in-depth by ensuring an adequate site:
   - *"The overall performance of the geological disposal system shall not be unduly dependent on a single barrier or function."*
     IAEA Safety Requirements for Radioactive Waste, April 2005*
2. To conform with NAS safety recommendations, as required by law:
   - *"recommend that compliance assessment be conducted for the time when the greatest risk occurs"*
   - *(Bob Fri at 9/21 ACNW meeting "we didn't recommend the alternative of a tiered approach")*
3. To meet EPA's own stated objective in relation to WIPP:
   - *"Ensure that people living near Yucca Mountain are protected to the same level as those living near [WIPP]"*
4. To meet IAEA "Principle 4" (in EPA-cited background document):
   "Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today."
5. Because it is the only standard that has a firm basis in EPA rulemaking